

Suisun Marsh Monitoring Program Annual Data Summary

Water Year 1998

Submitted in Fulfillment of:

Suisun Marsh Preservation Agreement

Suisun Marsh Monitoring Agreement

San Francisco Bay Conservation and Development Commission
Permit No. 35-78(M) and 4-84(M)

U.S. Army Corps of Engineers
Permit No. 16223E58, Special Condition 1

August 2000

State of California
Department of Water Resources
Environmental Services Office

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Introduction

This report summarizes data collected in the Suisun Marsh during water year 1998 (October 1, 1997 through September 30, 1998) pursuant to the following water rights decisions, agreements, and permits:

- State Water Resources Control Board Decision 1485, August 1978;
- Suisun Marsh Preservation Agreement 1987 (USBR and others 1987);
- Suisun Marsh Monitoring Agreement 1987;
- San Francisco Bay Conservation and Development Commission Permit No. 35-78(M), 1997¹ (for construction of the initial facilities, namely the Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall);
- San Francisco Bay Conservation and Development Commission Permit No. 4-84(M) 1991² (for construction of the Suisun Marsh Salinity Control Gates) (BCDC 1991); and
- U.S. Army Corps of Engineers Permit No. 16223E58 (for construction of the Suisun Marsh Salinity Control Gates), Special Condition 1, 1986 (USACE 1986).

This report and a separate report titled *Comprehensive Review of Suisun Marsh Monitoring Data*³ fulfill water year 1998 reporting requirements of the above-listed water rights decisions, agreements, and permits. The water year 1998 reporting requirements covered by each report are listed in Table 1.

Data summarized in this report were primarily collected by the Department of Water Resources (DWR) and the California Department of Fish and Game (DFG) and include

- general hydrologic data;
- continuous channel water specific conductance and tidal height fluctuation measurements;
- triennial marsh-wide vegetation survey update;
- waterfowl abundance; and
- salt marsh harvest mouse occurrence.

1. Amendment 7. The original was dated 1984.

2. Amendment 4.

3. The report *Comprehensive Review of Suisun Marsh Monitoring Data* is scheduled for publication in fall 2000.

Table 1 Suisun Marsh agreement and permit reporting requirements covered in Department of Water Resources reports

<i>Information</i>	<i>Permit or agreement requiring information^a</i>	<i>SMMP^a data summary report</i>	<i>Comprehensive review of Suisun Marsh data</i>
Monthly mean high tide salinity	SWRCB, SMMA	x	
SMHM surveys	USFWS BO	x	
Triennial vegetation surveys ^b	SMMA	x	
Waterfowl population surveys	SMMA	x	
Routine maintenance performed	BCDC	x	
Maintenance scheduled for next year	BCDC	x	
UC Davis fish sampling	SWRCB ^c , SMMA, USACE, BCDC		x
Larval fish survey			x
Striped bass tow-net survey	SMMA, USACE, BCDC		x
Phytoplankton and <i>Neomysis</i> surveys	SMMA, BCDC		x
Striped bass egg and larva survey	SMMA, USACE, BCDC		x
Juvenile chinook salmon monitoring	SMMA, USACE, BCDC, NMFS		x
Predator sampling	SMMA, USACE, BCDC, NMFS		x
Adult salmon migration study	SMMA, USACE, BCDC, NMFS		x
Water quality profiling program	SWRCB ^c		x

^a Abbreviations:

SMMP: Suisun Marsh Monitoring Program

SMMA: Suisun Marsh Monitoring Agreement (DWR and others 1987).

USACE: U.S. Army Corps of Engineers Permit 16223E58.

BCDC: San Francisco Bay Conservation and Development Commission Permits 35-78(M) and 4-84(M).

USFWS BO: U.S. Fish and Wildlife Service Biological Opinion 1-1-81-F-131.

SWRCB: State Water Resources Control Board D-1485.

NMFS: National Marine Fisheries Service 1993 Biological Opinion for Operation of the Federal Central Valley Project and the California State Water Project.

^b Surveys are conducted and results reported every three years.

^c Falls under D-1485 requirement to conduct special studies to develop a better understanding of the hydrodynamics, water quality, productivity and significant ecological interactions of the Suisun Marsh.

Background

The Suisun Marsh is located about 35 miles northeast of San Francisco in southern Solano County (Figure 1). The Suisun Marsh is one of the largest brackish water marshes in the United States. It provides habitat for numerous species of plants, fish, and wildlife and is a critical component of the San Francisco Bay Estuary and Sacramento San-Joaquin Delta.

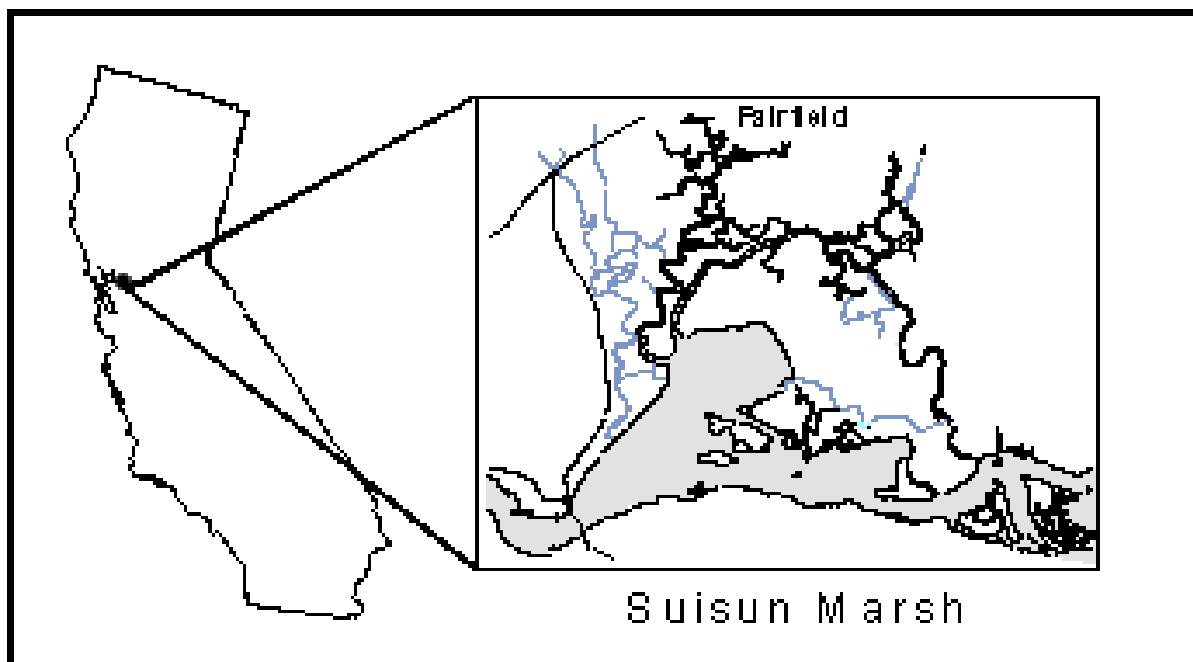


Figure 1 Location of Suisun Marsh

The DWR and the U.S. Bureau of Reclamation (USBR) store and divert water upstream of the Suisun Marsh. These and numerous other diversions can cause increased intrusion of saline water from San Francisco Bay to the Suisun Marsh and Sacramento San-Joaquin Delta (Delta) during hydrologically dry periods.

Water Rights Decision 1485 was adopted by the State Water Resources Control Board (SWRCB) in 1978 to protect water quality in the Delta and the Suisun Marsh. This decision was recently superseded by SWRCB Decision 1641, which was adopted on December 29, 1999. Decision 1641 was subsequently amended and adopted as Order WR 2000-02 on March 15, 2000.

Several agreements have been developed between DWR, USBR, DFG, and Suisun Resource Conservation District (SRCD) to address SWRCB requirements for the protection of the Suisun Marsh. These agreements relate to monitoring salinity conditions in the marsh, as well as monitoring impacts to wildlife and managed wetland operations. The agreements also cover the construction and operation of facilities for controlling salinity conditions in the marsh.

More detailed and specific background information on the Suisun Marsh and related monitoring programs is presented in Version 1 of the *Suisun Marsh Monitoring Program Reference Guide*. You may request a copy from the DWR Environmental Services Office at the address below, or access the guide on the Internet at <http://www.iep.water.ca.gov/suisun/curr-report/currrep.html>

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Attention: Mike Floyd

Data Summary

Hydrologic Conditions

Runoff Index, Water Year Classification, and Estimated Total Runoff for the Sacramento Valley

The Sacramento Valley Runoff Index for water year 1998 is 13.32 million acre-feet (maf). Water years with indices greater than 9.2 maf are considered “wet years.” The methods for calculating the runoff index and the water year classification system for the Sacramento Valley are described in Appendix A on [page 18](#). The calculation of the 1998 water year index is included in Appendix B on [page 19](#).

Estimated total runoff from the Sacramento Valley watershed for water year 1998 is 31.41 maf. Total runoff was estimated using the Sacramento Valley Four Rivers Index. Table 2 lists water year classifications, estimated total runoff, and the water year index for the Sacramento Valley for water years 1989 through 1998.

Monthly Mean Net Delta Outflow Index

Large amounts of precipitation fell in the Sacramento River watershed during January and February of 1998. This precipitation resulted in relatively high Delta outflow during the winter and spring months of water year 1998.

The Net Delta Outflow Index (NDOI) is the estimated daily outflow from the Delta calculated on a cubic foot per second (cfs) basis. Monthly mean NDOIs are calculated by averaging all daily NDOIs for a given month. The methods for calculating NDOI are described in Appendix C on [page 20](#).

The monthly mean NDOI during water year 1998 peaked in February at 231,175 cfs, as shown in Table 3. Monthly mean NDOIs remained relatively high throughout the rest of the year.

Table 2 Water year classifications 1989 through 1998

<i>Water year</i>	<i>Classification^a</i>	<i>WYRO^b (maf)</i>	<i>Index^a</i>
1989	Dry	14.7	6.1
1990	Critical	9.2	4.8
1991	Critical	8.4	4.2
1992	Critical	8.9	4.1
1993	Above Normal ^c	22.4	8.5
1994	Critical	7.8	5.0
1995	Wet	33.9	12.7
1996	Wet	22.2	10.2
1997	Wet	25.4	10.8
1998	Wet	31.4	13.3

^a State Water Resources Control Board 1995 Water Quality Control Plan classification system, found in Appendix A on [page 18](#).

^b WYRO is the water year runoff using the Sacramento Valley Four River Index.

^c 1993 is classified as an above normal wet year, instead of a wet year because it followed a critically dry year.

Table 3 Monthly mean Net Delta Outflow Index for water year 1998

<i>Month</i>	<i>Net Delta Outflow Index (cfs)</i>
October	4,842
November	10,154
December	15,350
January	71,738
February	231,175
March	104,748
April	88,512
May	67,633
June	71,835
July	30,967
August	20,007
September	20,119

Precipitation

Precipitation data are collected at DFG headquarters on Grizzly Island in the Suisun Marsh. Total monthly precipitation data for water year 1998 are listed in Table 4. January and February of 1998 were the wettest months during water year 1998. Rainfall during these months combined accounted for about 50% of the 1998 annual rainfall total for the marsh.

Suisun Marsh Salinity Control Gates Operations

The operational status of the Suisun Marsh Salinity Control Gates (SMSCG) during water year 1998 is listed in Table 5. The purpose and operation of the SMSCG are described in Appendix D on [page 22](#).

Table 4 Total monthly precipitation at Grizzly Island, October 1997 through September 1998

<i>Month</i>	<i>Rainfall (inches)</i>
October	0.75
November	4.50
December	2.52
January	6.88
February	7.69
March	2.12
April	1.87
May	2.26
June	0.20
July	0.00
August	0.00
September	0.22
Total	29.01

Table 5 SMSCG operational schedule during water year 1998

<i>Period</i>	<i>Operational status</i>	<i>Flashboards</i>
October 1, 1997 – October 13, 1997	Open, not operating	Out
October 14, 1997 – December 3, 1997	Operating	In place
December 4, 1997 – February 8, 1998	Open, not operating	In place
February 9, 1998 – September 30, 1998	Open, not operating	Removed ^a

^a The flashboards were removed from the SMSCG February 8, 1998, for flood control purposes and because they were no longer needed for salinity control in the marsh.

Water Quality Conditions

All SWRCB channel water salinity standards for the Suisun Marsh were met in water year 1998, as shown in Table 6. Suisun Marsh channel water salinity standards for water year 1998 are specified by SWRCB Order WR 95-6 and are expressed in terms of specific electrical conductance (SC). Salinity conditions in the marsh are monitored by measuring SC levels. Information on the Suisun Marsh channel water salinity monitoring program for water year 1998 is presented in Appendix E on [page 23](#).

Suisun Marsh channel water salinity conditions during water year 1998 were primarily a function of Delta outflow. Monthly mean high-tide SC levels at the beginning of the 1998 water year compliance season (October 1997 through May 1998) were above 10 milli-Siemens per centimeter (mS/cm) at all compliance stations except Station C-2. Operation of the SMSCG during the latter part of October and through November 1997 served to control salinity levels in much of the marsh. Heavy precipitation beginning in December 1997, followed by rapid increases in Delta outflow served to substantially reduce marsh salinity levels, as shown in Figures 2 through 4. Monthly mean high-tide SC at all compliance stations during water year 1998 remained far below SWRCB standards after November 1997.

Table 6 Monthly mean high-tide SC at Suisun Marsh compliance stations and SWRCB standards

<i>Month</i>	<i>Eastern Suisun</i>			<i>Western Suisun</i>		<i>Standard^a</i> (mS/cm)
	<i>C-2</i>	<i>S-64</i>	<i>S-49</i>	<i>S-42</i>	<i>S-21</i>	
October	9.49	11.35	13.32	15.29	15.02	19.00
November	9.86	7.86	8.80	10.97	10.89	15.50
December	1.97	4.65	6.19	7.27	6.99	15.50
January	1.48	2.99	5.47	5.83	5.72	12.50
February	0.30	0.24	0.50	1.09	--- ^b	8.00
March	0.16	0.30	0.65	1.30	1.31	8.00
April	0.19	0.37	0.57	1.23	1.20	11.00
May	0.20	0.44	0.71	1.23	1.18	11.00

^a Specified by SWRCB Order WR 95-6. Units are in milliSiemens per centimeter (mS/cm).

^b Data not available because of a power failure caused by flooding.

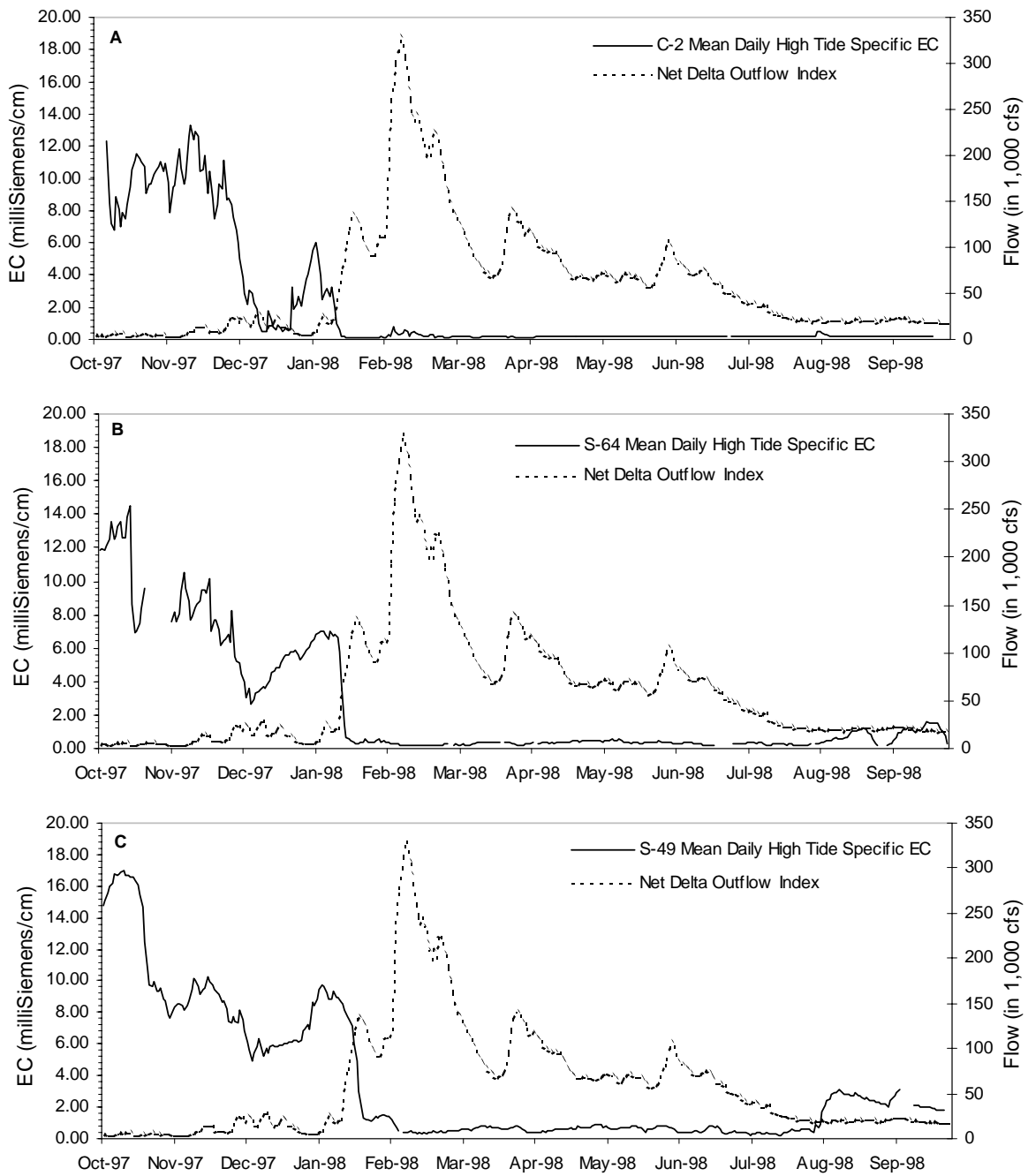


Figure 2 Specific electrical conductance and net delta outflow for water year 1998 at compliance stations: (A) C-2, (B) S-64, (C) S-49

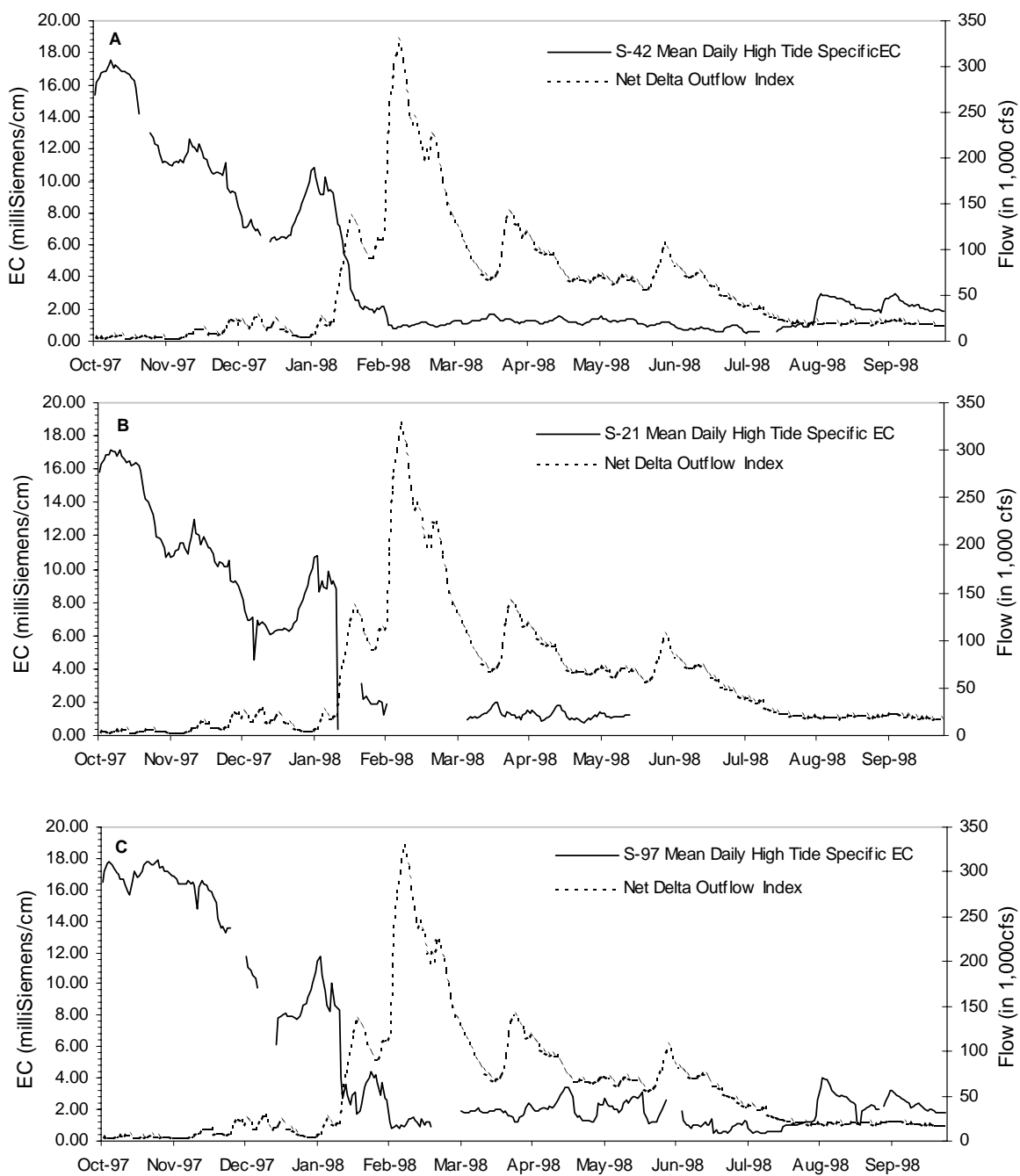


Figure 3 Specific electrical conductance and net delta outflow for water year 1998 at compliance stations (a) S-42, (b) S-21, and (c) monitoring station S-97

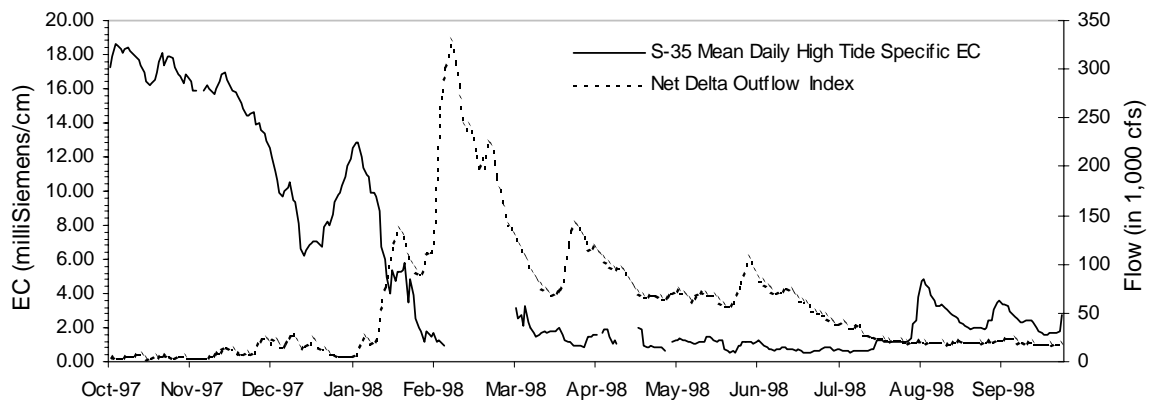


Figure 4 Specific electrical conductance and net delta outflow for water year 1998 at monitoring station S-35

During all months of the 1998 water year compliance season, monthly mean high-tide channel water SC levels were lower at eastern marsh compliance stations than at western marsh compliance stations. Salinity levels in the eastern portion of the marsh are typically lower than levels in the western marsh largely because of the proximity of the eastern marsh to the Sacramento River and Delta. Compliance Station C-2 had the lowest monthly mean high-tide SC levels throughout the compliance season, except during November 1997, because of SMSCG operation. Differences in salinity conditions at the compliance stations tend to diminish during periods of high Delta outflow, as was evident after November 1997.

Monthly mean high-tide salinity levels at monitoring stations S-35 and S-97 were elevated in comparison to levels at the compliance stations to the east, especially during November when the SMSCG were operated.

Wildlife

Salt Marsh Harvest Mouse Monitoring

In water year 1998, a total of eight areas in the Suisun Marsh was surveyed for presence of the salt marsh harvest mouse (SMHM). Seven of the areas were originally selected as “preferred” SMHM habitat by DFG in fulfillment of the U.S. Fish and Wildlife Service’s 1981 biological opinion for the *Suisun Marsh Management Plan*. The eighth area of the marsh surveyed during water year 1998 was the DFG Peytonia Slough Ecological Reserve. Background information on the SMHM monitoring program, the monitoring locations, and SMHM monitoring methods in the Suisun Marsh during water year 1998 are included in Appendix F on [page 25](#).

Species captured during water year 1998 included SMHM and other small rodents and shrews, as listed in Table 7. The exotic house mouse (*Mus musculus*) was captured at all sites except Crescent Unit and Pond 15. Total exotic house mouse captures exceeded the total for SMHM. However, capture rates were higher for SMHM at individual areas where that species was observed, except at the Benecia Industrial Unit.

No SMHM were captured at Joice Island or Hill Slough East. Two separate three-day capture efforts were performed at these two areas. Traps were placed near tidal wetlands at the high tide line along the edge of SMHM habitat in these areas during the first capture effort. Since no SMHM were captured during the first effort, a second three-day capture effort was conducted for both areas. Traps were placed below the high-tide line further into the SMHM habitat during the second effort. During the second effort the traps were only left open at night and during low tide to avoid drowning captured animals.

In addition to the above trapping efforts, SMHM were live-trapped and moved from the Morrow Island Distribution System dredge spoil site to a DFG set-aside area during water year 1998. The mice were moved to fulfill a permit condition for the 1997 Morrow Island Distribution System dredging. Twenty-eight SMHM were captured, ear-tagged, and translocated during approximately 4,000 trap nights along the system.

Waterfowl

The DFG conducted aerial waterfowl population surveys in the Suisun Marsh from September 1997 through January 1998. The results of the surveys are shown in Table 8. Summarized census estimates are included for northern pintail, mallards, other ducks, all ducks, all other waterfowl, and total waterfowl. Northern pintail and mallards are the more common waterfowl species found in Suisun Marsh and are listed separately as indicators of overall annual waterfowl abundance. Background information on waterfowl surveys in the Suisun Marsh is presented in Appendix G on [page 26](#).

The total waterfowl observed in the marsh during September 1997 and January 1998 were higher than their respective 1988–1997 ten-year averages. Total waterfowl numbers for October, November, and December of 1997 were lower than the ten-year averages for each of those months. The observed numbers of ducks and other waterfowl declined substantially from November to December 1997 in contrast to the ten-year averages, which show an increase during these two months.

The total number of waterfowl observed in the January 1998 midwinter survey was higher than the totals from the previous six midwinter surveys, as shown in Figure 5. Statewide waterfowl numbers were relatively similar to those observed in water year 1997 as shown in Figure 6.

Table 7 Water year 1998 survey results from Suisun Marsh salt marsh harvest mouse conservation areas

Period and location	No. traps set	No. trap-nights ^a	No. captured			
			SMHM ^b	<u>Mus</u> ^c	Voles ^d	Other unidentified species
August 4–7						
Crescent Unit	100	300	4 (1)			
Pond 15	100	300	7 (2)			
August 11–13						
Joice Island, near bridge	35	105		3		
Joice Island, S. of bridge	65	195		12		1 shrew
Hill Slough West	100	300	6 (2)	3	1	1 mouse
August 18–20						
Benicia Industrial Unit	100	300	28 (8)	45	29	10 harvest mice, 3 shrew, 1 rat
Hill Slough East, by dump	100	300		17		
August 25–27						
Hill Slough East, by dump	50	150		14		
Joice Island, S. of bridge	50	150		1		
September 15–17						
Pond 1	100	300	9 (4)	1		
Peytonia Slough	100	300	12 (4)	7	9	3 harvest mice

^a The number of nights multiplied by the number of traps set. For example, one trap set for three nights equals three trap nights.

^b Salt marsh harvest mouse (*Reithrodontomys raviventris*). Numbers in parentheses in this column are the number recaptured.

^c House mouse (*Mus musculus*).

^d *Microtus* spp.

^e *Reithrodontomys* sp.

Table 8 Waterfowl counted in Suisun Marsh during water year 1998 and average numbers counted from 1988 through 1997

<i>Month</i>	<i>Mallards</i>	<i>Pintails</i>	<i>Other ducks</i>	<i>All ducks</i>	<i>Other waterfowl</i>	<i>Total waterfowl</i>
Numbers observed for water year 1998						
September	10,056	16,030	3,147	29,233	50	29,283
October	15,402	24,270	31,301	70,973	7,692	78,665
November	17,175	15,355	34,797	67,327	8,439	75,766
December	6,425	7,715	26,967	41,107	4,511	45,618
January	13,046	27,280	67,357	107,683	43,420	151,103
Total	62,104	90,650	163,569	316,323	64,112	380,435
Average numbers observed for water years 1988 through 1997						
September	4,150	6,670	4,880	15,700	200	15,900
October	15,900	32,700	35,560	84,160	4,140	88,300
November	12,870	32,080	39,830	84,780	6,050	90,830
December	12,260	37,050	65,040	114,350	8,810	123,160
January	10,770	22,080	49,820	82,670	14,880	97,550

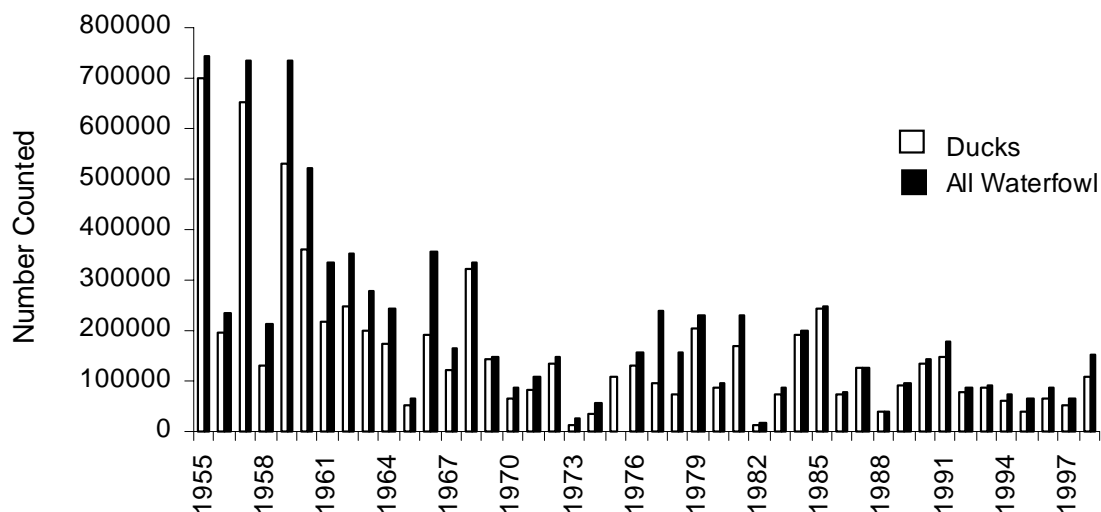


Figure 5 Midwinter count of ducks and total numbers of waterfowl in Suisun Marsh from 1955 through 1998

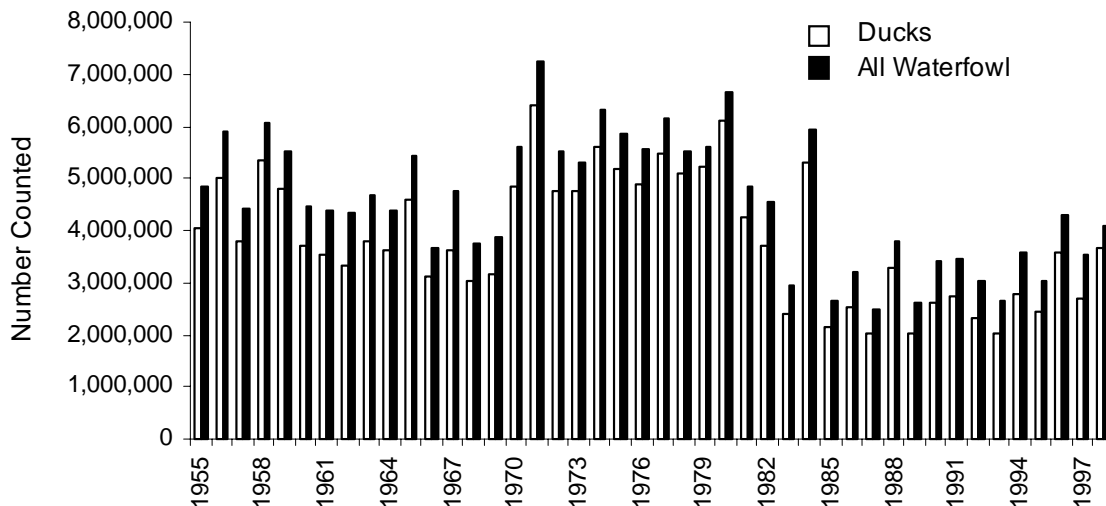


Figure 6 Midwinter count of ducks and total numbers of waterfowl in California from 1955 through 1997

Vegetation

During 1998 a pilot survey was conducted to help to develop revised survey methods to estimate marsh-wide vegetation distribution. DFG's Natural Heritage Division was consulted to develop the revised survey methods. Aerial photos were taken in June 1998. DFG staff toured the marsh and surveyed the vegetation to help with the proposal development process. The next vegetation survey is scheduled for water year 1999.

Maintenance

General Routine Maintenance

General routine maintenance at DWR Suisun Marsh facilities during water year 1998 included levee road grading and pothole repairs, weed control using herbicides and mowing, and water quality monitoring station repairs. These activities were conducted under a USACE Nationwide Permit No. 3 and BCDC Permit Number 35-78(M) (BCDC 1997).

Repairs to water-quality compliance and monitoring stations included tide well stabilization, and modification and repair of walkways, railings, bracing, and roofs. Monitoring Station S-16 on Suisun Creek became operational in May 1998 (Figure E-1, Appendix E, on [page 24](#)). This station replaced Station S-15, which was damaged during the flood of 1997 (DWR 1999).

Flood Damage Repair on the Roaring River Distribution System

During water year 1998, repairs were completed along approximately 4 of the 17 miles of levees along the Roaring River Distribution System (RRDS). The repairs were needed because of damage caused by the February 1998 flood. The damage was the result of breaches that occurred on the exterior levees of Van Sickle, Wheeler, and Simmons Islands. These breaches resulted in inundation of these islands and the RRDS. Under emergency permits, repairs were made to RRDS levees to bring the system back to its pre-flood condition. Debris carried into RRDS by the floodwaters was also removed.

Other Maintenance

Morrow Island Distribution System

In 1998, DWR continued the Morrow Island Distribution System (MIDS) maintenance project. Spoil material, which was removed from the MIDS in 1997, was moved from its temporary location and placed on MIDS levees to return the levees to their original specifications. The levees were raised to design specifications and road surfaces were re-established with the application of aggregate material. A few eucalyptus trees, felled by high winds during the previous winter and spring, were also removed from the distribution system and its levee slopes.

Permits were obtained to allow dredging of the first half mile of the C-line section of the MIDS. The C-line was dredged to reduce problems associated with sediment deposits from Grizzly Bay. Levee slopes were hydro-seeded with a mixture of native plants after the completion of the dredging.

Modifications to the M-line outfall were completed with the installation of new slide gates. The C-line outfall was also modified to allow proper operation.

Roaring River Distribution System

In 1998, maintenance work was conducted on the RRDS fish screen structure. During a routine diving inspection in October 1997, a 40-foot long by 4-foot deep void was discovered under the fish screen cutoff plates. In August and September 1998, repairs were made to the structure by placing sack gabions filled with riprap in the voids. Gabions were also placed up to the top of the cutoff plates. Loose rock was placed between the gabions to fill any remaining voids.

References

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- [USACE] U.S. Army Corps of Engineers. 1986. Regional General Permit No. 16223E58. San Francisco District, Regulatory Functions Branch.
- [USBR and others] U.S. Bureau of Reclamation, California Department of Water Resources, California Department of Fish and Game, and Suisun Resource Conservation District. 1987. Suisun Marsh Preservation Agreement, March 2, 1987. 15 p.
- [USFWS] U.S. Fish and Wildlife Service. 1984. Salt marsh harvest mouse and California clapper rail recovery plan. Portland (OR): U.S. Fish and Wildlife Service. 141 p.
- Wernette F. 1987. Plan to manage 1,000 acres of DFG lands in the Suisun Marsh for the salt marsh harvest mouse [interagency memorandum dated June 19, 1987]. Stockton (CA): Department of Fish and Game, Bay Delta and Special Water Projects Division.

Appendix A

Methods for Calculating Water Year Outflow Index and the Water Year Classification System for the Sacramento Valley

Water year hydrologic classification was determined following the methodology outlined in the State Water Resources Control Board *1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary* (SWRCB 1995a). Classification for the Sacramento Valley is as follows:

$$\text{Runoff Index} = 0.4 \cdot X + 0.3 \cdot Y + 0.3 \cdot Z$$

where:

X = Current year's April through July Sacramento Valley unimpaired runoff

Y = Current October through March Sacramento Valley unimpaired runoff

Z = Previous year's index⁴

Sacramento Valley unimpaired runoff is defined in the SWRCB plan as follows:

The Sacramento Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

The year type is determined based on the Runoff Index value as shown in Table A-1. The year type for the preceding water year remains in effect until the initial forecast of unimpaired runoff for the current water year is available.

Table A-1 Determination of year type based on index value

<i>Classification</i>	<i>Runoff Index (maf)</i>
Wet	Equal or greater than 9.2
Above Normal	Greater than 7.8 and less than 9.2
Below Normal	Equal to or less than 7.8 and greater than 6.5
Dry	Equal to or less than 6.5 and greater than 5.4
Critical	Equal to or less than 5.4

4. A cap of 10.0 maf is put on the previous year's index (Z) to account for required flood control reservoir releases during wet years.

Appendix B

Sacramento Valley Runoff Index Calculation for Water Year 1998

The following equation was used to calculate the Sacramento Valley Runoff Index for 1998:

$$\text{Index} = 0.4X + 0.3Y + 0.3Z$$

where:

Index = Water year index [million acre-feet (maf)]⁵

X = April 1998 through July 1998 Sacramento Valley unimpaired runoff (maf).

Y = October 1997 through March 1998 Sacramento Valley unimpaired runoff (maf).

Z = Previous water year's Index⁶

The Index for water year 1998 is:

$$0.4(12.56) + 0.3(17.65) + 0.3(10.00) = 13.32 \text{ maf}$$

5. A water year begins October 1 and ends September 30 of the following calendar year.

6. The maximum allowable value for Z is 10.0 maf.

Appendix C

Methods for Calculating the Net Daily Outflow Index

The Net Daily Outflow Index (NDOI) was determined following the methodology in the State Water Resources Control Board "1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary" (SWRCB 1995a). The NDOI is computed daily using the formulas 1 through 3 (all flows are in cubic feet per second).

1. Delta Inflow = SAC + SRTP + YOLO + EAST + MISC + SJR

where:

SAC = Sacramento River at Freeport mean daily flow for the previous day; the 25-hour tidal cycle measurements from 12:00 midnight to 1:00 a.m. may be used instead.

SRTP = Sacramento Regional Treatment Plant average daily discharge for the previous week.

YOLO = Yolo Bypass mean daily flow for the previous day, which is equal to the flows from the Sacramento Weir, Fremont Weir, Cache Creek and Rumsey, and the South Fork of Putah Creek.

EAST = Eastside Streams mean daily flow for the previous day from the Mokelumne River at Woodbridge, Cosumnes River at Michigan Bar, and Calaveras River at Bellota.

MISC = Combined mean daily flow for the previous day of Bear Creek, Dry Creek, Stockton Diverting Canal, French Camp Slough, Marsh Creek, and Morrison Creek.

SJR = San Joaquin River flow at Vernalis, mean daily flow for the previous day.

2. Net Delta Consumptive Use = GDELP – PREC

where:

GDELP = Delta gross channel depletion for the previous day based on water year type using the DWR's latest Delta land use study.⁷

PREC = Real-time Delta precipitation runoff for the previous day estimated from stations within the Delta.

7. The DWR is currently developing new channel depletion estimates. If these new estimates are not available, DAYFLOW channel depletion estimates shall be used.

3. Delta Exports⁸ = CCF + TPP + CCC + NBA

where:

CCF = Clifton Court Forebay inflow for the current day.⁹

TPP = Tracy Pumping Plant pumping for the current day.

CCC = Contra Costa Canal pumping for the current day.

NBA = North Bay Aqueduct pumping for the current day.

8. The term “Delta Exports” is used only to calculate the NDOI. It is not intended to distinguish among the listed diversions with respect to eligibility for protection under the area of origin provisions of the California Water Code.

9. Actual Byron-Bethany Irrigation District withdrawals from Clifton Court Forebay shall be subtracted from Clifton Court Forebay inflow. (Byron-Bethany Irrigation District water use is incorporated into the GDEPL term.)

Appendix D

Purpose and Operation of the Suisun Marsh Salinity Control Gates

The Suisun Marsh Salinity Control Gates (SMSCG) were completed and began operating in October 1988. The first year of operation was used to test the gates and official operation began in November 1989. The facility consists of a boat lock, a series of three radial gates, and flashboards. The gates control salinity by restricting the flow of higher salinity water from Grizzly Bay into Montezuma Slough during incoming tides and retaining lower salinity Sacramento River water from the previous ebb tide. Operation of the gates in this fashion lowers salinity in Suisun Marsh channels and results in a net movement of water from east to west. When Delta outflow is low to moderate and the gates are not operating, net movement of water is from west to east, resulting in higher salinity water in Montezuma Slough.

To help meet salinity standards, the SMSCG may begin operating in September and, depending on salinity conditions may continue operating through the end of May. When the channel water salinity decreases sufficiently below the salinity standards, or at the end of the control season, the flashboards are removed and the gates raised to allow unrestricted movement through Montezuma Slough.

Appendix E

Suisun Marsh Channel Water Salinity Monitoring for Water Year 1998

Compliance Stations and Monitoring Stations

Suisun Marsh channel water salinity standards for water year 1998 are specified by State Water Resources Control Board Order WR 95-6 (SWRCB 1995b). The salinity standards are expressed in terms of specific electrical conductance.

Channel water salinity standards for water year 1998 were in effect at five compliance stations. The compliance stations are listed in Table E-1.

Table E-1 Suisun Marsh salinity compliance monitoring stations

<i>Station Identification</i>	<i>Station Name</i>	<i>General Location</i>
C-2	Collinsville	Western Delta
S-64	National Steel	Eastern Suisun Marsh
S-49	Beldon's Landing	North-Central Suisun Marsh
S-42	Volanti	Northwestern Suisun Marsh
S-21	Sunrise	Northwestern Suisun Marsh

Two salinity monitoring stations, S-35 and S-97, did not have SWRCB salinity standards in effect during water year 1998. The station names and locations of these two monitoring stations are listed in Table E-2. The locations of the five compliance stations and two monitoring stations S-35 and S-97 are illustrated in Figure E-1.

Table E-2 Selected Suisun Marsh monitoring stations

<i>Station Identification</i>	<i>Station Name</i>	<i>General Location</i>
S-35	Morrow Island	Southwestern Suisun Marsh
S-97	Ibis	Western Suisun Marsh

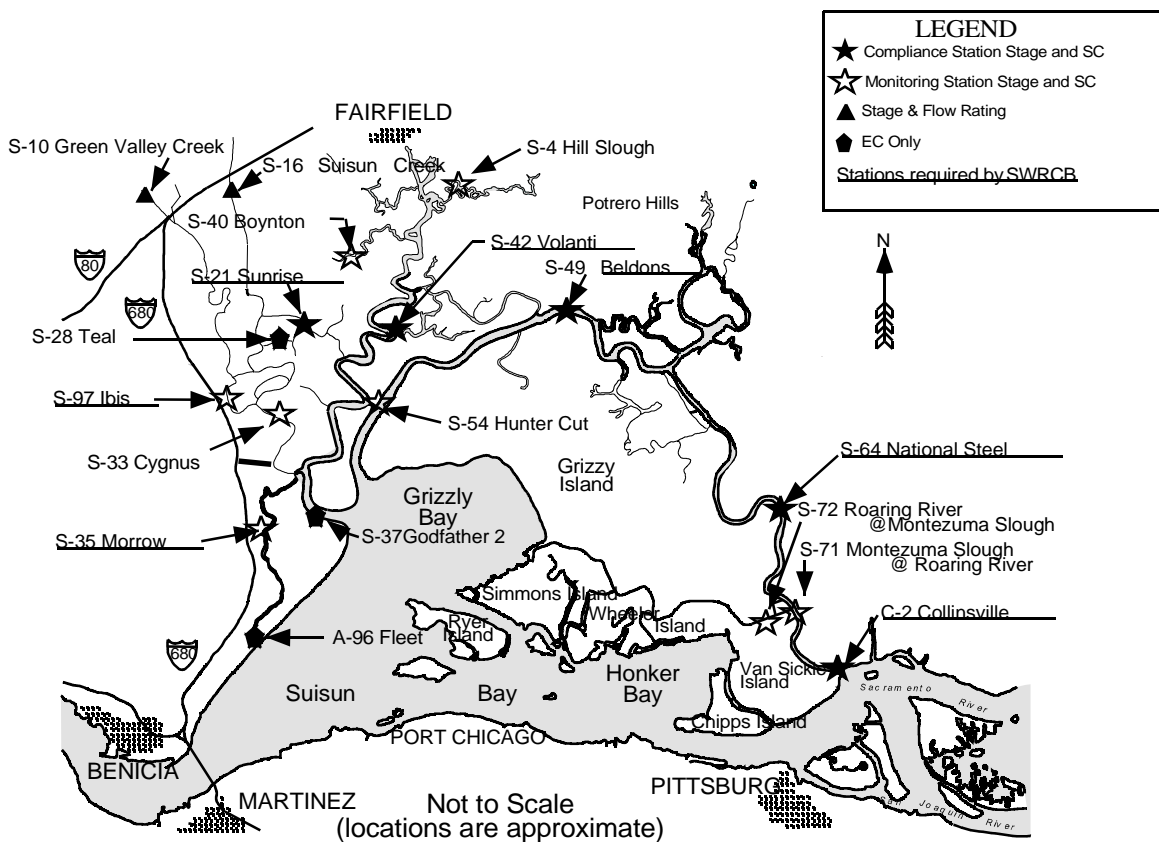


Figure E-1 Suisun Marsh compliance and monitoring stations, water year 1998

Data from monitoring stations S-35 and S-97 have been included in this report to provide additional information on salinity conditions in the western portion of the Suisun Marsh during water year 1998. Data from the eleven other water quality monitoring stations in the marsh were not included in this report, but are available by request by contacting the address referenced in the "Background" section of this report found on page 6.

Data Collection Methods

A detailed discussion of the data collection methods is found in Version 1 of the *Suisun Marsh Monitoring Program Reference Guide*. A copy of the guide is accessible on the Internet at <http://www.iep.water.ca.gov/suisun/curr-report/currrep.html>

Appendix F

Suisun Marsh Salt Marsh Harvest Mouse Monitoring During Water Year 1998

Background

The salt marsh harvest mouse (SMHM) (*Reithrodontomys raviventris*) is endemic to Suisun Marsh and other marshes of San Francisco Bay (USFWS 1984). The species was listed as endangered by the United States Fish and Wildlife Service (USFWS) in 1970 and by DFG in 1971.

The USFWS issued a biological opinion in 1981 for the implementation of the Suisun Marsh Management Plan. The biological opinion requires DFG, on behalf of DWR, to manage 1,000 acres of state-owned lands within Suisun Marsh as preferred SMHM habitat. A portion of the 1,000 acres is located within the Peytonia Slough Ecological Reserve. The DFG selected seven areas totaling 1,078 acres within the marsh (Figure F-1) to manage as SMHM conservation areas to fulfill the terms of the biological opinion (Wernette 1987).

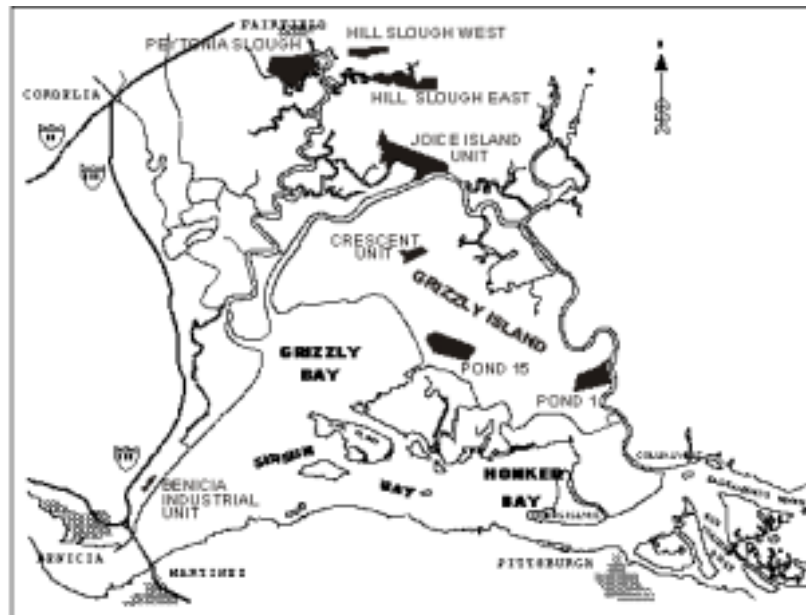


Figure F-1 Salt marsh harvest mouse set aside lands and the Peytonia Slough Ecological Reserve

Data Collection Methods

A detailed discussion of the data collection methods is found in Version 1 of the *Suisun Marsh Monitoring Program Reference Guide*. A copy of the guide is accessible on the Internet at <http://www.iep.water.ca.gov/suisun/curr-report/currrep.html>

Appendix G

Suisun Marsh Waterfowl Surveys During Water Year 1998

Background

The Suisun Marsh is an important wintering area for waterfowl along the Pacific Flyway. Waterfowl commonly wintering in Suisun Marsh (DWR 1984) include

- northern pintail (*Anas acuta*);
- mallard (*Anas platyrhynchos*);
- American wigeon (*Anas americana*);
- green-winged teal (*Anas crecca*);
- northern shoveler (*Anas clypeata*);
- ruddy duck (*Oxyura jamaicensis*);
- canvasback (*Aythya valisineria*);
- white-fronted goose (*Anser albifrons*); and
- Canada goose (*Branta canadensis*).

Migrant waterfowl begin arriving in the marsh each year during August. The highest waterfowl counts are usually obtained by October. Waterfowl numbers in the marsh typically remain fairly constant from October through December and then usually decline in January.

Survey Methods

The Department of Fish and Game (DFG) conducted semi-monthly aerial waterfowl population surveys in the Suisun Marsh from September 1997 through January 1998. Census estimates (DFG 1998) were provided to DWR in digital and tabular form.

A detailed discussion of the data collection methods is found in Version 1 of the *Suisun Marsh Monitoring Program Reference Guide*. A copy of the guide is accessible on the Internet at <http://www.iep.water.ca.gov/suisun/curr-report/currrep.html>